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PROPHET OF NINTH PLANET

Prof. Percival Lowell's Prediction is Fulfilled

(See page 179)

Vol. XVII No. 467

Black as Coal, Dense as Zinc

Astronomy

THE new planet resembles the earth and the other inner planets in size and brightness more nearly than it does its huge closer neighbors, Jupiter, Saturn, Uranus and Neptune, Dr. John Q. Stewart, Princeton astronomer, told Science Service.

Black as coal, nearly as dense as iron, twice as dense as the heaviest earthly surface rocks. So Dr. Stewart's estimates reveal the new planet. Because of the great pull of gravity shown by Dr. Stewart's figures, a man there could jump less than half as far as he could here on the earth.

From the observations showing the planet to be of the fifteenth magnitude, and the prediction of Prof. Lowell that it would have about seven times the mass of the earth, Dr. Stewart has made a preliminary calculation of some of the planet's characteristics.

"The planet is very faint," he said. "At the same distance from the sun and earth, Neptune would be about sixty times brighter. Only Mercury and Mars would be fainter. Either Lowell's predicted mass is not strictly correct or the planet is very dense or very black."

Dr. Stewart's tentative results make the planet's density between six and seven times that of water; its diameter 14,000 miles; its angular diameter seventeenths of a second of arc, or about a twenty-five hundredth the apparent diameter of the moon; the force of gravity on its surface more than twice that of the earth, so that with a spring balance a 150-pound man would weigh something like 325 pounds on the planet. He also estimates that it reflects about four per cent of the light falling on it, so that it would be little brighter than a coal pile.

Confirmation of the Lowell Observatory's discovery of the trans-Neptunian planet has been obtained in photographs made at the Steward Observatory of the University of Arizona. The natural skepticism with which the scientific world always greets any discovery of such importance will now largely be dispelled by this independent observation.

The first photograph was obtained by E. F. Carpenter with the observatory's three-foot reflecting telescope on Saturday, March 15. As the planet could not be identified by the character of its image on the plate, it was necessary to take a second photograph on a later night, in order to determine which object had moved. Stormy weather delayed taking of the second plate until Monday night, March 17.

The Solar System

	Millions of Miles From Sun	Revolution Around Sun, Years	Diameter, Miles	Rotation Period
Sun	—	—	864,392	25 d. 7 h. 48 m.
Mercury	36.0	.24	3,009	88 days
Venus	67.2	.62	7,575	225 days
Earth	92.9	1.00	7,917.8	23 h. 56 m. 4 sec.
Mars	141.5	1.88	4,216	24 h. 37 m. 23 sec.
The Asteroids—1500 or more tiny bodies a few miles in diameter at an average distance from the sun of 258,000,000 miles.				
Jupiter	483.3	11.86	86,728	9 h. 55 m.
Saturn	886.1	29.46	72,430	10 h. 14 m.
Above planets, except asteroids, all known since ancient times.				
Uranus	1782.8	84.02	30,878	10 h. 45 m.
Discovered by Sir William Herschel in England, March 13, 1781.				
Neptune	2793.4	164.79	32,932	unknown
First recognized as planet by J. G. Galle in Germany, September 23, 1846.				
New planet.	*4000.0*	*282.00*	*14,000*	unknown
Discovery announced by Lowell Observatory March 13, 1930. Values in italics not certain.				

The Answer Is

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Naming the Planet

Naming the trans-Neptunian planet is the next problem of astronomers, and numerous suggestions have been made, which may or may not be followed. One of the most obvious suggestions is to name it Lowell after the astronomer who predicted where it would be found; just as Uranus was known for a time in England as Herschel and Neptune in France as Leverrier. Herschel himself suggested Georgium Sidus after the reigning king, and a parallel is the suggestion that the new planet be named Hoover.

But as a good Harvard man, Lowell himself would probably have preferred a classical name, in accordance with the other planets. Kronos was one of the first suggestions in this class, after the Titan who was the son of Uranus and father of Jupiter. But Kronos was identified by the Romans with Saturn, so it would probably not be fair to put him in twice. Another son of Saturn, Neptune, is already in the sky, so another suggestion is that the planet be named after the third brother, Pluto. One appropriate name that has been suggested is Minerva, because it was by the wisdom of man, of which she was the patron goddess, that the planet was located.

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The Sun's New Trans-Neptunian Planet

Astronomy

Lowell Observatory Confirms Its Founder's Prediction

By Dr. V. M. Slipher
Director, Lowell Observatory

THE Lowell Observatory has made the discovery of a celestial body whose rate of motion and path among the stars indicates that it is a new member of the sun's family of planets out beyond Neptune.

Twenty-five years ago, Dr. Percival Lowell, director and founder of the Observatory at Flagstaff, Ariz., began a mathematical investigation for a planet beyond Neptune, based upon certain unaccounted for motions of the planet Uranus. The problem of locating such a body in the heavens was a very difficult one, and involved an enormous amount of intricate computations. In 1914 he announced in an extensive memoir as a result of his mathematical work, the position of the predicted body.

The search of the sky directed by Dr. Lowell's theoretical investigation was begun by photography in 1905 and has been continued with interruptions to the present time. Use has been made of the best available instruments covering that band around the sky in which the planets travel. Early in 1929 the new Lawrence Lowell telescope, a special instrument for the research, was put in operation.

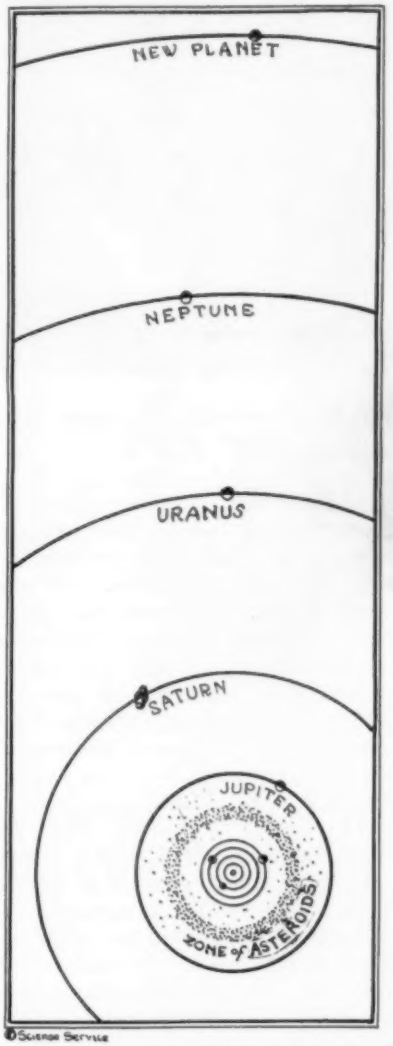
Some weeks ago Mr. C. W. Tombaugh found an object on his plates with this telescope, which has since been followed carefully also with the Lowell forty-two inch reflector, by C. O. Lampland. It has been observed visually with the large refractor by the various members of the Lowell Observatory staff.

The object is now (March 13) about twelve seconds west from delta Geminorum, westward motion about two seconds per day. The position of the new object substantially agrees with Lowell's prediction of its position and distance. Due to the very great distance of this body and its consequent small apparent size even in a large telescope it has been necessary in learning of its nature to rely almost wholly upon a critical analysis of its motion during the past seven weeks covered by the observations. It will therefore be necessary to continue observation of it for months in order to learn its orbit and period and true nature.

Science News-Letter, March 22, 1930

The discovery of a new planet beyond Neptune by Lowell Observatory is one of astronomy's outstanding discoveries. The year 1930 will be remembered for the detection of the ninth planet.

The diagram shows the relative distance of the new planet from the sun. From the sun outward, the unlabeled planets are: Mercury, Venus, Earth, Mars.



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A cranberry placed 3¼ miles from a globe two feet in diameter make a model of the new planet in relation to the sun. Mercury, innermost planet, would be represented by a mustard seed 82 feet from the two foot globe representing the sun; Venus by a pea at 142 feet; the earth by a little larger pea at 215 feet; Mars by a grain of corn at 327 feet; the asteroids by 1500 or more grains of dust and sand scattered in a circle about 700 feet away; Jupiter by an orange at a quarter of a mile; Saturn by a small orange at 2/5 of a mile; Uranus by a cherry at 1¼ mile. The nearest star would be represented by a globe a foot or more in diameter at 7500 miles.

By Clyde W. Tombaugh
Discoverer of New Planet

IN searching for the new planet I was carrying out a systematically arranged program and was fortunate in being assigned to this work with the splendid new Lowell photographic telescope. I was determined to examine the ecliptic thoroughly and carefully all the way around the sky. In the course of several months of arduous research I had been ever expecting to find the new planet predicted by Prof. Lowell.

Examination of plate after plate failed to reveal it, but many asteroids and variable stars were found. I had figured out just how the object sought for should appear. The ecliptic survey was nearly half completed when one day I found an object on my plates that fulfilled expectations. Almost instantly I felt that it was the one looked for, and, of course, felt greatly elated. I was reminded of my sister's class prophecy back in high school days.

The work on the planet, however, is far from finished. Now that it is found, the elements of its orbit, and much else concerning it, must be learned, so doubtless it will be a much observed object. I am not a mathematician, and so the work on the planet is being carried on largely by the senior members of the observatory staff.

I was born February 4, 1906, near Streator, Ill., the son of Muron and Della Tombaugh; received my elementary education in the rural schools and attended Streator High School for two years. The family moved to Kansas in 1922, where I assisted my father in raising wheat. I was graduated from Burdette High School in 1925.

Since then my summer seasons were given to farming, my winters to constructing reflecting telescopes. During recent years much of my spare time was spent in observing with my telescopes and reading astronomical books. In January, 1929, I came to the Lowell Observatory and commenced work with the telescope with which the new planet was discovered.

Science News-Letter, March 22, 1930

New York home-making experts recommend molasses for children's sweets because of its rich content of iron and calcium.

Astronomers Acclaim New Planet

Astronomy

By Dr. Harlow Shapley
Harvard College Observatory

THE report from Flagstaff of the discovery of a faint, slow-moving object which can most reasonably be interpreted as a ninth major planet of the solar system again emphasizes man's ability to see beyond his power of vision and to grasp what lies beyond his reach. Astronomy is rich in similar feats of prediction, but probably no prediction, except the forecasting years in advance of the exact place and time of a total solar eclipse, appeals so much to the average man as this extension of the bounds of our own solar system.

The existence of the companion of the bright star Sirius was known from theory long before it was first glimpsed with a powerful telescope. Many stars vary in brightness in such a manner that mathematical analysis demonstrates the existence of companions that never have been seen.

The most famous astronomical prediction was, of course, the one that led to the discovery of Neptune in 1846, in much the same way as Lowell's computations of fifteen years ago now lead to the detection of a body that may be a major member of the sun's family.

Professor Percival Lowell and Professor William Pickering of Harvard have been the most active among the many astronomers who have felt certain that the residual irregularities in the motion of the outer planets were definite proof of the existence of one or more outlying companions.

To astronomers, the discovery is most significant in its bearing on theories of the origin of the planetary system and on the past history of the sun.

Other Planets Foreseen

By Dr. Frank Schlesinger
Director, Yale Observatory

The detection of a planet beyond Neptune constitutes one of the greatest discoveries in the history of astronomy. If this planet was found near the place predicted by the late Percival Lowell the discovery constitutes a great triumph for him and also for the present staff of the Lowell Observatory.

Clyde W. Tombaugh, discoverer of the new planet

To find so faint an object is an extremely difficult task and reflects great credit on Dr. Lampland and Dr. Slipher. It is easy to predict that other planets still farther from the sun remain to be discovered but their detection will be exceedingly difficult because it is to be expected that they will be fainter than the object now announced by the Lowell observers.

The History of Planets

For the third time in the history of the world, the research of astronomers has revealed a new member of the solar system—the family of bodies, large and small, that revolve around the parent sun from which they were born many ages ago. To Professor Percival Lowell, born in Boston on March 13, 1855, belongs the credit, though he died on November 12, 1916, and now rests in a stone mausoleum at the observatory he founded, close to the dome of the great telescope with which he did his work. At this observatory, at Flagstaff, Arizona, his successors, under the leadership of Prof. V. M. Slipher, have located the new planet, close to the place in the heavens where the founder's researches predicted that it would be.

Curiously enough, Prof. Lowell was born on the 74th anniversary of the first modern planetary discovery—that of Uranus by Sir William Herschel on March 13, 1781. With a peculiar sense of the fitness of things, Dr. Slipher chose March 13, 1930, 75th anniversary of Lowell's birth and 149th anniversary of the discovery of Uranus, to announce to the world that Prof. Lowell's prediction had been correct.

September 23, 1846, brought the eighth major member of the solar system to the attention of astronomers, and from that time to now, no additions have been made. But this is probably not the last. The failure of Uranus to move exactly as expected led astronomers to explain the discrepancies as due to the gravitational attraction of an unknown planet beyond. From these studies the position of Neptune was predicted and the planet was found. As many more years of observations of Uranus became available, still other discrepancies appeared, discrepancies which Lowell studied and used, as we now know, to such good advantage. As Uranus, Neptune and the new planet itself are studied in more detail, and have moved farther in their slow plodding course, other discrepancies, which are now vaguely glimpsed, will appear and still other planets—the tenth and perhaps the eleventh and twelfth, will be discovered. But each will be more difficult than the last, and it may be that the most distant planets will forever continue to move around the sun, unsuspected by earthly man.

Sir William Herschel was a musician at fashionable Bath, in England, when he became interested in astronomy. He made a number of telescopes, all reflectors, with dish-shaped mirrors to bring the rays of light to a focus. Finally, on the night of March 13, 1781, he came home from a concert and, according to his habit, went out to the back of his house where he and his sister Caroline swept the skies. Then he was using a little telescope with a mirror only seven inches in diameter. Sweeping through the constellation of the twins, now high in the western sky, and the same group (*Turn to page* 186)

The Prediction of the New Planet —A Classic of Science

Astronomy

MEMOIR ON A TRANS-NEPTUNIAN PLANET, by Percival Lowell. Memoirs of the Lowell Observatory, Vol. 1, No. 1. Lynn, Mass. 1915.

1. Ever since celestial mechanics in the skillful hands of Leverrier and Adams led to the world-amazed discovery of *Neptune* a belief has existed begotten of that success that still other planets lay beyond, only waiting to be found. Leverrier himself, with the far-sight of genius, was firmly of this view, though unfortunately oversanguine of the happy date of its demonstration. In consequence since his time many attempts have been made to indicate the position of one or more of these unknowns, attempts for the most part of no scientific value because not founded on rigorous mathematical investigation. For so complicated is the problem that all elementary means of dealing with it lead only to error. The sole road to any hope of capture lies through the methodical approach of laborious analysis.

Not only are all summary processes worse than useless, engendering false ideas in their conclusions, even a supposed proximate analysis proves not to be approximate in its results. Thus the simplifying of the problem by the assumption of a circular orbit for the unknown, originally suggested by Tisserand and worked out in the present case with all due reserve by M. Gaillot, and more or less likewise by M. Lau, betrays intrinsic evidence of inadequacy. For M. Gaillot reduces the mean of the outstanding squares of the residuals only from 1.04 to 0.88, which, considering that the admission of a disturbing body must necessarily reduce them is self-confessedly hardly a satisfactory solution.

Still more questionable is the attempt to explain planetary irregularities on the supposition of two unknowns, both traveling in circles; as we have no guarantee that the habit of either body is of this obliging simplicity. In fact, there is a distinct antecedent probability that it is not.

2. To any real solution, the problem must be attacked analytically with all the rigor possible. Before entering upon such an investigation it is well to state the problem generally, showing the data upon which it rests and the limitations to which it is necessarily subject. For lack of appreciation of these points has led to mistaken ideas of what is or is not possible.

3. The theory of a planet cannot in the nature of things be exact; and this for three reasons:

(1) the observations on which it is founded are necessarily more or less in error; (2) the theory itself may be more or less imperfect; (3) an unknown body may be acting of which perforce no account has been taken. The latter is a particularly insidious pitfall inasmuch as the greater part of the disturbance it causes can be concealed by suitable changes of the disturber's elements in the following way:

Since the biggest terms in the perturbation are those arising from terms of long period or terms having nearly the period of the disturbed body, these can in large part be thrown upon the mean motion, the epoch, the eccentricity and the place of the perihelion of the disturbed body. For a long period term in the perturbation has for a century or so nearly the same effect as an alteration in the mean motion or in the epoch or both; while one having nearly the period of the perturbed planet may similarly be represented by altering the supposed eccentricity or perihelion place of the latter. Not only may these terms so be accounted for; by the process of solution adopted they must necessarily be. For the corrections of the elements are obtained from the observational equations themselves by the method of least squares.

Consequently the residuals left by the theory are not at all the outstanding perturbations, but only such small part of them as cannot be got rid of by suitable shuffling of the cards. We have then no guarantee that our supposed elements are the real ones, but only the best attainable under the assumption *that no unknown exists.* Every theory of a planet is thus open to doubt, seeming more perfect than it is. It has been legitimately juggled to come out correct, its seeming correctness concealing its questionable character.

4. The test of the existence of an unknown body thus left out of account lies in the substantial reduction of the outstanding residuals of the theory by its subsequent admission. The reduction must be substantial to be indicative, because a slight betterment necessarily follows the introduction of another factor among the adjustable quantities. . . .

8. At the present time no such simple problem confronts us. We cannot use *Neptune* as a finger-post to a trans-Neptunian as *Uranus* was used for *Neptune* because we do not possess observations of *Neptune* far enough back. A disturbed body must have pursued a fairly long path before the effects of perturbation detach themselves from what may be well represented by altering the elements of the disturbed. *Neptune* has not been known long enough to do this. Analysis of its residuals, made in the course of this investigation, yielded no rational result.

Secondly, in 1845 the outstanding irregularities of *Uranus* had reached the relatively huge sum of 133″. To day its residuals do not exceed 4″.5 at any point of its path.

9. Adams' method was direct and masterly; Leverrier's, equally original, was simpler and more complete. . . .

10. Originally the above course [Leverrier's] was pursued in the present investigation, but with extensions in the number and character of the terms calculated in the perturbation in order to render it more complete. The residuals used were those of Leverrier's theory of *Uranus* of 1873, brought up to 1906 by the Greenwich observations. The outcome was very satisfactory, indicating an unknown body in

longitude 244° at 1912.0

11. In 1912. the subject was continued by solving again with Gaillot's residuals in place of Leverrier's. Gaillot's theory is to be found in the *Annales* of the *Paris Observatory*, Vol. 28, and in addition to its general excellence has two qualities which specially commend it. The first is that the adopted masses of the several planets concerned are probably the best we possess today, having been taken with great judgment by M. Gaillot. The full merit of this can be appreciated only by those familiar with most works on celestial mechanics, in which, after excellent analytical solutions, values of (*Turn to page* 182)

the quantities involved are introduced on the basis apparently, of the respect due to age. Nautical Almanacs abet the practice by never publishing, consciously, contemporary values of astronomic constants; thus avoiding committal to doubtful results by the simple expedient of not printing anything not known to be wrong.

His second mark of merit is in giving the residuals between his theory and observations.

With Gaillot's residuals, values for the longitude came out, according to the terms included in the perturbations, changed elimination equations, etc., as

209° and 203° for Jan. 1, 1912;

on the whole, a corroboratory result. . . .

In the present case, it seemed advisable to pursue the subject in a different way, longer and more laborious than these earlier methods, but also more certain and exact; that by a true least-square method throughout. When this was done, a result substantially differing from the preliminary one was the outcome. It both shifted the minimum and bettered the solution. In consequence, the whole work was done *de novo* in this more rigorous way, with results which proved its value.

14. This investigation we shall now give in detail. The work was done in duplicate, and as a further check, wherever possible, the functions involved were plotted so that any important deviation from their proper curves could be detected at sight. Besides the outcome from the standpoint of accuracy, the procedure disclosed the fact that points of commensurable period introduce no discontinuity into the perturbative function. . . .

[There follow 90 pages of tables, formulae and computations.—Ed.]

Conclusions

62. Assembling the various solutions, got by considering such diverse terms and in such different ways, we are first struck by the general concordance the results exhibit. This is significantly displayed in the several sets of elements, in the comparatively close resemblance of the excentricities, masses, perihelion places and mean longtitudes of the epochs deduced. Even the resulting heliocentric longitudes of the unknown for a given date, July 0, 1914, come out in rather striking accord. . . .

That they are not more so will perhaps be one's second thought. But when we look into the matter more closely, we begin to realize some reason for this. Even in his problem Leverrier discovered that his preliminary solution was entirely altered by the omission of two apparently trifling terms. Much more then should this be the case in the present investigation where we are perforce obliged to neglect terms, the coefficients of which we know to be large. . . . We should rather expect, then, disheartening discordance from the second order results; but such is not the case. . . .

65. That Leverrier's solution gave him limits which were erroneous shows how necessary to a full comprehension of the problem is the rigorous and more complete method of solution. This does not detract from the great analytical skill displayed by both Adams and Leverrier in their masterly attack on the problem. That alone deserved success. Why it attained it is nevertheless a cause for some surprise, for Leverrier left out terms bigger than two he retained. The explanation would seem to lie in the nearness of *Neptune* and the near circularity of its orbit. *Neptune* turns out to have been most complaisant and to have assisted materially to its own detection.

How important the circularity or non-circularity of the orbit is to the finding the unknown may be seen from Gaillot's circular solution which, although it gives a major axis for *X* (45 astr. units) not inconsistent with that from the elliptical one, is entirely discordant (295°) with the latter when it comes to assigning the present position of the perturbing body.

66. It becomes pertinent here to note what both Leverrier and Adams considered a satisfactory betterment of the *Uranian* residuals, and which in view of the then relatively imperfect theories of the other planets it certainly was. The sum of the squares of the residuals left by Adams' theory was 348, and by Leverrier's, 615. This was an enormous improvement on Bouvard's, or even on Bouvard's corrected by Leverrier. Yet both are much larger than the sum with which we at present start as our initial data.

The solutions indicate the place of the perturbing matter supposing it represented by a single body which is the only practical and workable supposition. For though other bodies doubtless exist beyond, their effect is not likely, owing to distance, to be such as seriously to modify the primary solution. If the matter should be distributed in an asteroidal ring, although the theory would remain correct, the matter itself would escape recognition.

Finally it is vital to notice how it is the far residuals that give us information of the presence of an unknown not the near ones. These have been made small by proper shift of the elements of the perturbed body and can always be so minimized. It is only the distant ones which cannot be thus reduced and which therefore constitute our guideposts in the case. . . .

68. But that the investigation opens our eyes to the pitfalls of the past does not on that account render us blind to those of the present. To begin with, the curves of the solutions show that a proper change in the errors of observation would quite alter the minimum point for either the different mean distances or the mean longitudes. A slight increase of the actual errors over the most probable ones, such as it by no means strains human capacity for error to suppose, would suffice entirely to change the most probable distance of the disturber and its longitude at the epoch. Indeed the imposing "probable error" of a set of observations imposes on no one familiar with observation, the actual errors committed, due to systematic causes, always far exceeding it.

In the next place the solutions themselves tell us of alternatives between which they leave us in doubt to decide. If we go by residuals alone, we should choose those solutions which have their mean longitudes at the epoch in the neighborhood of 0°, since the residuals are there the smallest. But on the other hand this would place the unknown now and for many decades back in a part of the sky which has been most assiduously scanned, while the solutions with epoch around 180° lead us to one nearly inaccessible to most observatories, and, therefore preferable for planetary hiding. Between the elements of the two, there is not much to choose, all agreeing pretty well with one another.

Owing to the inexactitude of our data, then, we cannot regard our results with the complacency of completeness we should like. Just as Lagrange and Laplace believed they had proved the eternal stability of our system, and just as further study has shown this confidence to have been misplaced; so the fine definiteness of positioning of an unknown by the bold analysis of Leverrier or Adams appears in the light of subsequent research to be only possible under certain circumstances. Analytics thought to promise the precision of a rifle and finds it must rely upon the promiscuity of a shot gun after all, though the fault lies not (*Turn to page* 190)

Maya Stone Road Links Two City Ruins

Archaeology

By Captain Robert R. Bennett

An ancient stone road or causeway, now swallowed by the jungle, runs 69 miles due magnetic east and west between the two unexplored Maya city ruins, from Coba in the east to end abruptly at Yaxuna. Chichen Itza, the best known Maya ruin, is seven miles northeast of Yaxuna as the crow flies.

Our expedition of the Museum of the American Indian, Heye Foundation of New York City, has just returned from the ancient land of the Maya in Mexico. We discovered the destination of this remarkable stone road, or sacbe as the Maya call it, which previous investigators reported leaving Coba and running westward into unknown forest growth.

My companion, Crawford Johnson of Washington, and myself, who with half a dozen Indians and necessary pack mules formed the expedition, penetrated the bush where no white explorer had hitherto trodden. We first visited Coba, a known but slightly explored Maya city which Col. Charles Lindbergh and his companions saw from the air last fall during their airplane explorations of the ancient domain of the Maya. Not more than half a dozen white men have previously visited this ancient ruins. Among them were Dr. A. V. Kidder, of the Carnegie Institution of Washington, who with George G. Heye of the Heye Foundation, suggested to me the desirability of exploring the elevated stone highway leading from the city. Dr. T. W. F. Gann, British explorer, Dr. Sylvanus G. Morley and J. Eric Thompson, American archæologists, and Ernest L. Crandall, American photographer, are other white men who have seen this ruined city. Our objective was not the exploration of the city although we did find that there are four lakes there instead of the two commonly supposed to be in its vicinity.

Only a few years have elapsed since archæologists challenged the very existence of old stone roads in the Maya area. A search into the literature shows that the stone roads were first mentioned in Stephens' "Travels in Yucatan," published in 1843. This pioneer wrote:

"There is a tradition of a great paved way made of pure white stone called in the Maya language, Sacbe, leading from Kabah to Uxmal on which the lords of those places sent messengers to and fro bearing letters written on the leaves and bark of trees."

He states further, after a brief hearsay description of Coba and a temple there: "From this edifice there is a calzada or a paved road of 10 or 12 yards in width running to the westward to a limit that has not been discovered with certainty but some aver that it goes into the direction of Chichen Itza."

Even Dr. Gann, as late as 1926 when he visited Coba, concluded from hearsay evidence obtained from natives that the stone road leaving Coba ran to Chichen Itza.

But Dr. Sylvanus G. Morley, of the Carnegie Institution, assures me that no stone road enters Chichen Itza and our exploration showed conclusively that the roads runs from Coba to Yaxuna. Indeed, one is forced to the conclusion that the road we explored was built before the magnificent Chichen Itza was erected. This means that the road is probably nearly two thousand years old.

Maya stone road in the jungle near Capt. Bennett's camp number seven.

Conditions in the land of the Maya are much as they were a century or so ago when Maya ruins first attracted attention, except that mule trains now penetrate the thick forests bringing to civilization the one commercial product of Quintana Roo. This is chicle, from which is made America's popular chewing gum. Only a few years have passed since the hostility of the Indian natives, descendants of the old Maya, has turned to friendship.

A lack of water in the jungle region has been a great deterrent to exploration. I was warned by Indians and others that it was dangerous to venture off into the wild regions from Coba and Yaxuna without carrying many kegs and tins of water transported on mule back. Frequently Indians refused to cut their way along the ancient stone road extending into the wilderness. They demanded plentiful supplies of water. Our exploration was made easier by the fact that we discovered four cenotes or deep pools of water in the coral rock, located about 10 miles apart. But for these happy water holes, previously unknown, we would have been greatly inconvenienced.

It is evident that the stone road that we explored was built for ceremonial purposes. It lies straight east and west as though a master engineer had laid it out. Ruins of magnificent temples are strewn along the road. We found one that undoubtedly had never been seen by the eyes of a white man before. Near Coba the road rises sharply and runs directly through one ruined temple, as though for some ceremonial purpose. At the western end, at Yaxuna, the ruins bearing the name of a miserable Indian village of 17 males about a mile and a half away, the road abruptly ends in the midst of unexplored temples and handsome monuments.

As the ancient Maya had no domestic animals, it is believed that their old stone roads were used for foot traffic, ceremonial processions, and as a path for fleet-footed messengers. The rough stone rubble base now so visible and inconvenient for travel, was rendered perfectly smooth and white by a coating of cement long since broken by heavy jungle growth and climatic conditions.

Several strange stelae or stone monuments were found and, while no one has been able to explain their significance, they may be markers placed at various (*Turn to page* 188)

Cheap Helium

Helium has been produced at the government plant at Amarillo, Texas, at a cost which compares favorably with that of hydrogen.

More than a million cubic feet of the non-inflammable airship gas, of which the United States has a monopoly, was made during January for a net cost to the government of $9.64 the thousand cubic feet, the U. S. Bureau of Mines, which built and operates the plant, reports. Inflammable hydrogen, which is still used in lighter-than-air craft of other nations, can be made at costs varying from $3 to $9 the thousand cubic feet.

With greater output the cost of helium can be lowered still more. The plant did not operate during December and February because of lack of demand. The million cubic feet made in January would fill two-fifths the volume of the airship Los Angeles.

Helium contained in the Navy blimp C-7, which made the first trip with the new lifting gas in 1921 from Langley Field, Va., to Washington, cost approximately $150 the thousand cubic feet. Since that time refinements in process and volume production have gradually reduced the cost of separating the rare element from natural gas in which it is found in small quantities.

Chemistry—Aviation
Science News-Letter, March 22, 1930

Metallic Poisoning?

The illness which has stricken some hundred persons in Oklahoma is baffling health authorities. Is it due to some chemical poison contained in the Jamaica ginger which all the patients seem to have drunk? Or is it caused by some germ? Perhaps this is another outbreak of meningitis. Frequently new and mysterious maladies turn out to be meningitis upon investigation, health officials have recalled.

So far not even a trace of any of the commoner metals has been detected in the samples of the suspected Jamaica ginger submitted for examination, the assistant state health commissioner of Oklahoma, J. P. Folan, has reported to the U. S. Public Health Service in Washington.

The symptoms of the illness seem to point to metallic poisoning, Mr. Folan said in his report. Most of the extract believed responsible for the outbreak of illness has been consumed or disposed of.

The report of the assistant state health commissioner seems to indicate that Oklahoma authorities believe the illness was caused by chemical rather than bacterial, or germ, poisoning, health authorities pointed out. Possibly the suspected Jamaica ginger was the only common factor in all the cases of illness.

Medicine
Science News-Letter, March 22, 1930

1500 Miles for Food

Milk for New York City's 10,000,000 metropolitan population is hauled by rail an average distance of 300 miles, Billings Wilson, deputy manager of the Port of New York Authority, has determined.

The average haul of foodstuffs has been estimated to be 1,500 miles, he declared. This includes shipments from Florida, Texas and foreign countries.

"Old milk cars containing several hundred 40-quart cans, covered with ice in summer, are gradually being displaced by modern glass-lined, vacuum protected tank cars," Mr. Wilson told the engineers. The milk is pumped directly from the cars into pasteurizing plants.

Economics
Science News-Letter, March 22, 1930

Taking Temperature

The health of a Diesel engine is now determined by taking its temperature. A thermometer in the exhaust of these oil-burning, internal combustion engines, which are increasing rapidly in popularity, can be relied upon to show how combustion is proceeding in the cylinders, says a recent issue of *Power*.

Curves have been drawn to give operators the correct value of temperature for different loads. For example, the exhaust temperature of the four-stroke cycle, air-injection Diesel is directly proportional to the load, the points for the curve forming a straight line. Its full load temperature is 700 degrees Fahrenheit. Apparently most types of Diesels have a no-load exhaust temperature of about 230 degrees.

Engineering
Science News-Letter, March 22, 1930

Automatic Radio Station

Ten automatic weather bureaus, scattered about by airship on the arctic ice, equipped to broadcast weather conditions three times a day for a year without human attendance, are contemplated by the International Society for Exploration of the Arctic Regions by means of aircraft. The plans of the society, generally known as Aeroarctic, were described by Dr. Fridtjof Nansen, its leader.

IN VARIOUS CI

Already an automatic weather observatory has been constructed which tells the temperature, air pressure and humidity by radio for use on a small balloon. In inhabited regions, balloons are often sent up with small recording instruments, and the finder is expected to return it to the proper authorities. As there is no one in the Arctic regions to perform this service, it is necessary to provide the radio transmitter. This operates for about two hours, sending its observations back to the airship base.

The larger apparatus, like the other an invention of Prof. Meltchaneff, weighs about 1½ tons. It is said that ten of these could be carried on an airship and dropped on the ice at various points. Three times a day they would transmit their observations back to civilization. By visiting them once a year by airship, they could be kept in continual operation.

Radio
Science News-Letter, March 22, 1930

Observatory Moving

Astronomical observatories, with their solidly mounted telescopes and large domes, are not ordinarily thought of as wandering institutions, but the Radcliffe Observatory, at Oxford, is now preparing to move permanently to South Africa. With its instruments, which include a double telescope for both photography and visual use, the larger lens 24 inches in diameter, the southern skies will be studied. The trustees of the observatory have just sold their grounds, which extend over nine acres, to the Radcliffe Infirmary. They have, however, taken a five-year lease on the grounds, so that the present researches on the motions of stars can be completed.

Dr. W. H. Steavenson, prominent British astronomer and authority on optics, is now in South Africa. With a 6-inch telescope he is testing the astronomical conditions in the neighborhood of Pretoria, to locate the best site for the observatory.

Astronomy
Science News-Letter, March 22, 1930

Algae for Nitrogen

Bacteria, which have hitherto had a nearly complete monopoly on the important business of capturing nitrogen from the air and making it available for the feeding of higher plants, may have to yield a part of their throne to larger but almost equally

SCIENCE FIELDS

humble plants, the blue-green algae. Experiments reported to the technical journal *Science* by Dr. F. E. Allison and H. J. Morris of the U. S. Department of Agriculture indicate that at least one species of blue green algae, kin to the multitudinous plants that give color to stagnant water, is able to fix nitrogen in considerable quantity when supplied with normal sunlight, or in the absence of sunlight if it is given sugar.

Earlier experiments had indicated something of the kind, but the two Government scientists wanted to check up under more rigid control conditions, so they repeated the work with more elaborate precautions. One of the greatest difficulties was to get a culture of the algae without any bacteria in it, for bacteria have a habit of sticking very tightly to the slimy sheaths of the larger plants. They finally cleared their algae of the last bacterium by irradiating it with ultraviolet light, which kills bacteria but does not harm the algae in the doses used.

Chemistry
Science News-Letter, March 22, 1930

Rate of Radium Decay

Doubt that radium and allied substances can be made to change the rate at which they decay into other elements is expressed by Mme. Curie, discoverer of radium, in commenting on experiments by L. Bogojavlensky, which were supposed to show such a change.

In 1,750 years half of a given quantity of radium will have changed into radon, or radium emanation, and helium. Mme. Curie points out that very careful precautions are necessary before any change in this rate can be established. She has made a number of experiments herself, on radium, radon and polonium, another radiotive element, by exposing them to the action of various rays, and has not been able to find any evidence of a change in rate.

Physics
Science News-Letter, March 22, 1930

World Birthday Party

The "dean of American medicine," Dr. William Henry Welch of the Johns Hopkins University, Baltimore, will be given an international party on his eightieth birthday next April 8.

President Hoover will speak at the celebration in Washington. Other celebrations will be held simultaneously in London, Paris, Berlin, Leipzig, Tokio, Pekin, Baltimore, Cincinnati, New Haven and New York, where friends, colleagues and former students will gather to honor Dr. Welch.

The program in Washington will be broadcast so that those participating at the other ceremonies may hear what is said and done at Washington. The executive committee in charge of the celebration is headed by Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research and a former pupil of Dr. Welch's.

"America owes more to Dr. Welch than can ever be told in any tributes," the committee stated. "Half a century ago he began his leadership in modernizing American medicine. Through the reforms which he has instituted in medical study, through his researches, the many hundreds of doctors trained by him, and the vital public health measures which he has inspired, it is literally true that millions have benefited from his contribution."

Medicine
Science News-Letter, March 22, 1930

Mountains Named

Two noted American scientists, one of whom is still living, have received the distinction of having mountains named for them, at a recent meeting of the United States Geographic Board.

A hitherto unnamed peak in the Sierra Nevada range, in Fresno County, Calif., was named Mount Merriam, in honor of Dr. C. Hart Merriam of Washington, D. C., an outstanding authority on the classification and systematic distribution of animals, and well known also for his botanical studies. Standing 13,067 feet high at the end of the range, his mountain is a landmark for the entire surrounding country.

A peak a few miles distant from Mount Merriam has been named Mount Royce, in honor of Dr. Josiah Royce, who died in 1916. Born in California, Dr. Royce first became a geologist and naturalist, but later made his reputation as one of the world's leading philosophers.

A third natural monument named at the session of the Geographic Board is less than a mountain in size, but still imposing. This is Rodley Butte in the Umpqua National Forest in Oregon. It was named for Oscar Rodley of the Forest Service, who met his death by drowning in 1928.

Geography
Science News-Letter, March 22, 1930

Philadelphia Ruins

The ruins of Philadelphia have been the subject of research by a German archæological expedition, which conducted preliminary surveys and determined the outlines of the principal streets of the forsaken city. Members of the party, however, have expressed great regret and disappointment over the fact that the farmers of the surrounding region were permitted to cart off the rubbish that covered most of the ruins, and even to carry away the building materials themselves, so that further scientific work has become impossible.

This is not the opening paragraph of an imaginative tale of 3030 A. D. Neither is it the story of what might have happened if the Great War had turned out differently. It is a summary of a sober scientific article in the German journal *Forschungen und Fortschritte*, written by Prof. Dr. Paul Viereck of Berlin.

The Philadelphia which he visited, and in which he conducted researches which were concluded mostly before the war, was once a town in the Faiyum, a valley oasis some distance southwest of Cairo, Egypt. It was, as its name suggests, Greek in origin. It was founded by a monarch of the house of the Ptolemies, which was set over Egypt by Alexander the Great and continued to rule until it was extinguished by the suicide of Cleopatra. There were at least two other Philadelphias in the ancient world, one in Palestine and the other in Asia Minor.

This Philadelphia of the Faiyum, Prof. Viereck states, seems to date from the third century B. C.; it was abandoned some time early in the Christian era. Like its modern namesake, it was laid out with straight streets in a checkerboard pattern, oriented to the points of the compass. The German expedition's hopes of making a detailed excavation of the whole town were defeated by the inroads of the Egyptian peasants, who removed the rubbish to use as fertilizer on their fields, and later carried off the bricks from the ancient walls.

The program of excavating a whole ancient town, to find out what the lives of the common people of ancient Egypt were like, was later realized by an American expedition, sent out by the University of Michigan, which excavated the ruins of a nearby Greco-Egyptian town, Karanis.

Archaeology
Science News-Letter, March 22, 1930

Trans-Neptunian Planet—*Continued*

in which the Lowell planet has appeared, he saw something strange. Instead of a tiny point of light, like the thousands of stars that flashed across his view, this was a disk of light. Always modest, he did not suppose that he had found a new planet, the first such discovery ever recorded, but suggested that it might be a comet. But as the object was watched and watched, its character as a planet was established. This brought fame to Herschel as an astronomer, King George III, then on the throne, gave him a pension, and requested that he move to Slough, near Windsor Castle. Herschel gave up his music, devoting his life to a study of the stars and becoming one of the greatest astronomers of all times. The discovery of Uranus made this possible.

Incidentally, the name that Herschel proposed for the planet was not Uranus, but "Georgium Sidus," in honor of the king. English astronomers later suggested that it be called Herschel, and this name was actually used for a time in England. Finally, however, the suggestion of the German astronomer, Johann Elert Bode, prevailed, and it was named Uranus, thus according with the mythological names given the inner planets.

Great as was Herschel's discovery, Uranus was literally waiting to be picked up by some keen eye. Bright enough to be just visible to the naked eye under good conditions when one knows just where to look, it could not have long avoided discovery as telescopes became more numerous. But the next discovery was of a different kind, for before it was seen in the sky, it was detected in a mass of figures in a long and involved calculation.

Uranus had only been observed a few years when it was found that it did not move as it should, according to Newton's laws. The pull of Saturn and Jupiter, its nearest and largest brother planets, were allowed for, but even so there was a discrepancy. By 1845 this was about two minutes of arc—about a fifteenth of the moon's diameter. This was the difference between where Uranus should be and where it was actually observed. A number of suggestions were made, one—a rather obvious one—being that it was due to the gravitational pull of a farther and unknown planet. But that anyone could figure out from the discrepancy the location of the unknown planet seemed to many to be a hopeless task.

A 35-year-old French astronomer, Urbain Jean Joseph Leverrier, decided that he could do it. In September, 1846, he completed his laborious computations and wrote to Johann Gottfried Galle, then an assistant at the Observatory at Berlin, the following:

"Direct your telescope to a point on the ecliptic in the constellation of Aquarius, in longitude 326°, and you will find within a degree of that place a new planet, looking like a star of about the ninth magnitude, and having a perceptible disk."

On the night of September 23 Galle turned his telescope to this point. He had an accurate map of the stars in this region, so all he had to do was to check each on the map against those in the sky. The extra one in the heavens, then, must be the planet. Within half an hour after he started looking, he found the stranger within 52 minutes, less than a degree, of the place that Leverrier had indicated. The telescope that he used is today preserved in the great German Museum at Munich. Galle lived to the age of 98 and died as recently as 1910.

Though Leverrier and Galle were the first to make the planet known to the world, an Englishman, John Couch Adams, deserves just as much credit as the Frenchman. In the autumn of 1845, this young student at Cambridge, then 26, completed his calculations, with no suspicion of Leverrier's similar efforts across the Channel. He called at the Greenwich Observatory, in London, to present his results to the Astronomer-Royal, Sir George Airy. But that gentleman was at dinner when he called, and the butler declined to disturb him. Adams left his paper, which Sir George acknowledged, but then pigeon-holed.

By July, 1846, however, after Leverrier had published two preliminary papers on the subject, Sir George became interested, and asked Prof. Challis, at Cambridge, to look for the planet. Challis, however, had no maps of the region and so he had to measure the position of a number of stars, night after night, to determine which was moving, for the planets move among the stars. But he had started too late, and while he was still searching, Galle won the race, and Adams, through no fault of his own, lost the honors that might have been his. Then it turned out that Challis had actually measured the new planet twice, the first time early in August, but had not analyzed his observations to determine which object was the planet. Further checking of older records showed that another French astronomer, Lalande, had actually noted it 50 years earlier, without knowing what it was.

The planet was named Neptune by the French, with a touch of sarcasm, it has been said, because England ruled the seas, and they were jealous of the apparent attempt of England to take their honors away from them by pushing the claims of Adams.

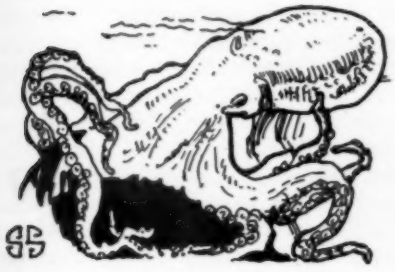
Neptune revolves once in its orbit around the sun in 165 years, so that since its discovery it has made just half a revolution. Uranus, however, with a year equal to 84 of ours, has made about two revolutions. If there were to be any gravitational pull by still another planet, the more rapidly moving planet would show it best. Sure enough, a slight discrepancy was noticed in the motion of Uranus that could not be explained by the attraction of any known body. It is only about 5 seconds, a twenty-fourth as large as it showed in 1845. Lowell took advantage of this discrepancy but his was a task far more difficult than that of Leverrier or Adams.

The observations were not so easy, either. Lowell died in 1916. Finally, last year, after various delays, the Lowell Observatory obtained a new telescope, furnished by his brother, Dr. A. Lawrence Lowell, president of Harvard University. This has a photographic lens 13 inches in diameter with a focal length of 63 inches, so that it is really a huge camera. Covering a wide area of the sky, it is especially adapted to the search for a planet, and after a year of study of photographs made with it, the planet was found. C. W. Tombaugh was the astronomer who first actually observed it, but to the entire Lowell Observatory staff, including its director, Dr. V. M. Slipher, his brother E. C. Slipher, Dr. C. O. Lampland, K. P. Williams, T. B. Gill, G. H. Edwards and J. C. Duncan belongs the credit for the third planetary discovery.

Science News-Letter, March 22, 1930

NATURE RAMBLINGS

By Frank Thone



The Tastes of an Octopus

That "there is no accounting for tastes" is one of the most ancient of proverbs. If tastes are difficult to account for in the familiar human sphere, they are simply beyond comprehension in the weird world of the waters. There tastes and smells come to the inhabitants through the same medium, and are indistinguishable one from the other.

So, at least, a noted German naturalist found some time ago, when he was experimenting with the taste-smell sense of the octopus. The creature showed no differentiation between the two senses, and reacted in only two ways, according to whether it liked or disliked the "taste-odor" which the scientist introduced into its tank. It tried to capture the agreeable ones, like fish juice, and it tried to get away from the ones it did not like or could not understand.

Curiously enough, the octopus seems to taste (or smell) with its arms. The experimenter killed an octopus, cut off its arms, and dropped fish-juice into the water. Instantly the severed limbs writhed toward the attractive taste-odor.

The chemical sense of the octopus is very acute, the experiments showed, especially toward strange or disagreeable taste-odors. Musk seems to be a particular aversion of the octopus (is one of its enemies musk-scented?), for it tries to escape from traces so minute that they cannot be measured by the methods of chemical analysis. It will endure a measurable concentration of quinine, about five thousandths of one per cent. Acetic acid, the essential part of vinegar, will make it move at a concentration about five times that great, but the much stronger hydrochloric acid does not affect the many-armed mollusc at any strength under one hundredth of a per cent.

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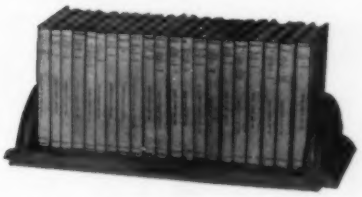

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Maya Road—*Continued*

distances along the road. On the side of each of these stelae there is cut into the stone a perpendicular line with two small crosswise lines at top and bottom and a longer crosswise line in the middle. In addition to this strange cross device, there may have been writings on the other side of the stone which climatic conditions have defaced. Should further research show that these stelae do actually mark distance it will be an interesting contribution to our knowledge of the Maya since no indication has previously been obtained that the Maya had a unit of length measure.

The road between the two ruined cities is elevated from the surrounding terrain by retaining walls of heavy stone of various heights, depending upon the irregularity of the ground. The roadbuilders attempted to keep the road level so far as possible. We did not follow every foot of the road, but our party penetrated into the unexplored regions from the two ends of the road sufficiently far to convince us that the road runs directly between the two cities. Some fifteen miles from the Yaxuna end, a branch of the road runs off toward the northwest. The existence of this branch was hitherto unknown.

So well did the ancient Maya build that it would seem feasible not long in the future for modern engineers to improve the ancient road and make it passable for automobile traffic. Then it would be possible to speed from ancient Coba to ancient Yaxuna in a few hours. A week or more of mule-back traveling is now necessary.

Science News-Letter, March 22, 1930

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A Valuable Weed

MILKWEED, once considered as a possible source of rubber but long since dismissed, may yet become a useful crop plant, in the opinion of Dr. Fisk Gerhardt of the Iowa Agricultural Experiment Station.

In a report to *Industrial and Engineering Chemistry,* Dr. Gerhardt shows that milkweed compares favorably with other plants of commercial value, such as flax and kapok. He reports a yield of 30 bushels of seed, 280 pounds of floss, and one ton of air-dry stems per acre. He finds that its seeds are rich in oil, that its seed fibers are buoyant and do not absorb water readily, and that its stem fibers compare favorably with hemp and flax.

Analysis shows that the dark brown seed of the milkweed is similar in composition to that of several of our crop plants. It contains 21.2 per cent. of oil, as compared with 19 per cent. in cotton seed, and 33 per cent. in flax seed. It is classified as a semi-drying oil. By bleaching it is possible to make it a clear, colorless product similar to various plant oils now in use as food.

The fibers just beneath the bark and along the outer surface of the woody stem are soft, pliable, almost white, and resemble flax very closely.

The silvery white seed fibers of the milkweed plant have been called "the cotton of the north." All attempts to use them in the textile industry, however, have so far failed, as the fibers are rather brittle. Nevertheless they do have a low moisture absorption and a high degree of buoyancy. These specific qualities make them especially fitted for use in playground equipment, life savers, and insulating materials. They resemble kapok in these respects.

"With the pronounced increase in our consumption of cellulose," Dr. Gerhardt says, "it becomes obvious that our future supply will of necessity originate in annual plants rather than in those plants requiring years to attain sufficient maturity, such as trees. In the development of future sources, the by-product return in the form of oils, gums, resins and protein concentrates will continue to be a factor of prime importance. The commercial demand for these latter commodities is gradually approaching in magnitude that of our cellulose industries. Among the primary problems, then, now confronting the chemist and plant breeder are those concerned with further exploitation of our present cellulose wastes and the development of our most promising sources of fibrous materials."

Science News-Letter, March 22, 1930

Traces of Sloth, Man Found Together

Paleontology

FURTHER evidence of the possible contemporaneous existence of man and ground sloths, extinct camels and other ancient animals has been found in Gypsum Cave near Las Vegas, Ariz., by the joint expedition of Southwest Museum and the California Institute of Technology. Eleven feet deeper than the sloth bones previously reported as associated with human remains in the same cave, the party has discovered camel bones and the bones of the native American horse, which had been extinct for many centuries before the coming of the white man. Two hoofs, with the original horny covering still in place, were a part of the latter find.

The cave has also yielded deeply buried archæological remains, including articles of human manufacture and charcoal, associated with sloth guano. This suggests, though it does not definitely prove, association between human beings and living ground sloths.

This new discovery puts forward once more the question that has been raised repeatedly in the Southwest during recent years, of the possible great antiquity of man on this continent. It has been taken for granted that ground sloths, native horses, and American camels were extinct for many thousands of years before the coming of man to America. Some estimates put the gap as wide as 100,000 years.

However, if the researches now in progress here and elsewhere do finally demonstrate that human beings and these animals lived side by side, it will still not prove that man was here 100,000 years ago. It may be that the animals survived their officially announced date of demise, and lingered on until eight or ten thousand years ago, when even conservative estimates of the antiquity of man will admit human immigration into the western world.

Science News-Letter, March 22, 1930

An observer who rises 10,000 feet can see 50,000 square miles of the earth.

Among the industrial enterprises of ancient Phoenicia was the working of lead mines in Spain from which place they distributed the metal.

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ELEMENTS OF CHEMISTRY

By HARRY N. HOLMES, Professor of Chemistry, Oberlin College, and LOUIS W. MATTERN, Head Teacher of Chemistry, McKinley Technical High School, Washington, D. C.

The authors maintain that an intelligent appreciation of the industrial life of the nation and of the foundations of world power is no longer possible without some knowledge of chemistry. Hence, in this elementary textbook, they set out to convince the student that his own personal comfort, safety, pleasure, health, and well-being are dependent upon chemical reaction. By the use of "Problems Yet to Be Solved" the subject matter is given spice and interest with the lure of the unknown and the conviction of the wonderful service that chemistry can give to the world.

The textbook has several distinctive features: organic chemistry, from carbon to nutrition, is held together as one section of related effort; problems dealing with gas law correction relegated to the appendix to be selected according to the needs of the classes; the electronic explanation of valence and oxidation and reduction are also in the appendix; considerable space is devoted to the chapters on fuels and colloidal dispersions, extending the treatment of molecular dispersions on true solutions.

Fabrikoid. 12°, ill. 520 pages. $1.80.

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Prediction of the Planet—*Continued*

more in the weapon than in the uncertain bases on which it rests. But to learn of the general solution and the limitations of a problem is really as instructive and important as if it permitted specifically of exact prediction.

For that, too, means advance.

Summary

69. This investigation establishes the following:

1. By the most rigorous method, that of least squares throughout, taking the perturbative action through the first powers of the excentricities, the outstanding squares of the residuals from 1750 to 1903 have been reduced 71% by the admission of an outside perturbing body.

2. The inclusion of further terms yielded solutions in accordance with the first.

3. Solutions taking the years 1690-1715 also into account agreed substantially with those from the years 1750-1903.

4. So did those in which the additional years to 1910 were considered.

5. The second part of the investigation, in which the solutions were made for the second powers of the excentricities as well, gave conformable results.

6. When the probable errors of observation were reckoned, the outstanding squares of the residuals of theory excluding an outside planet proved to have been reduced by its admission from 90% to 100% nearly, the solutions seeming to confirm one another. . . .

7. Though this would indicate an absolute solution of the problem, it must be remembered that the actual as against the probable errors of observation might decidedly alter the result; and so might the terms above the squares in e and e' necessarily left out of account.

8. The investigation disclosed two possible solutions in each case, one with the mean longtitude of the epoch around 0°, one with it around 180°; and that this duality of possible place would necessarily always be the case.

9. On the whole, the best solutions for the two gave: mean longitude of epoch around 0°: epoch 22°.1; semi-axis 43.0; mass 1.00; excentricity .202; place of perihelion 203°.8 heliocentric longitude July 0, 1914—84°.0: mean longitude of epoch around 180°: epoch 205°.0; semi-axis 44.7; mass 1.14; excentricity .195; place of perihelion 19°.6; heliocentric longitude July 0, 1914—262°.8: the unit of mass being 1/50,000 the mass of the *Sun*.

10. It indicates for the unknown a mass between *Neptune's* and the *Earth's;* a visibility of the 12-13 magnitude according to albedo; and a disk of more than 1″ in diameter.

11. From the analogy of the other members of the solar family, in which excentricity and inclination are usually correlated, the inclination of its orbit to the plane of the ecliptic should be about 10°. This renders it more difficult to find.

12. Investigations on the perturbation in latitude yielded no trustworthy results. This is probably because the excentricity as well as the planet's other elements enter as data into the latitude observation equations.

13. The perturbative function is not discontinuous at the commensurability of period points, a fact hitherto in doubt.

14. That when an unknown is so far removed relatively from the planet it perturbs, precise prediction of its place does not seem to be possible. A general direction alone is predictable.

Science News-Letter, March 22, 1930

New Comet

BEYER'S comet, discovered on March 11 by an astronomer at the Hamburg Observatory in Germany, has been observed by Prof. George Van Biesbroeck, at the Yerkes Observatory, Williams Bay, Wis. This announcement was made by the Harvard College Observatory.

Prof. Van Biesbroeck observed it on the night of March 13. Then it was in the constellation of Auriga, the charioteer, now high in the southwestern evening sky. Astronomically, its position was 6 hours 5 minutes 10 seconds right ascension and 33 degrees 25 minutes and 14 seconds north declination. It is still moving northwards, and is of the tenth magnitude, visible only in a medium-sized telescope.

According to word received at the Harvard Observatory from Europe, it has been found that photographs of this part of the sky made by Prof. Prager at the University of Berlin's Observatory also showed the comet, though it was not recognized until Dr. Beyer's discovery. These early positions, however, will greatly aid in calculating the comet's path. Three separate observations are required to compute an orbit, and the farther apart they are, the more accurate is the result.

Astronomy
Science News-Letter, March 22, 1930

FIRST GLANCES AT NEW BOOKS

SCIENCE AND THE NEW CIVILIZATION—Robert A. Millikan—*Scribner's* ($2). Eight stimulating essays by one of America's leading physicists are here gathered together into an attractive book. In the one on "Available Energy" he effectively dispels the fear that some human control over atomic disintegration might start a process which would not stop until our entire earth had vanished. "The great majority of the elements, such as constitute the bulk of our world, are in their state of maximum stability already," he declares. Some other chapters are on "The Last Fifteen Years of Physics," "Michelson's Economic Value" and "Alleged Sins of Science."

General Science
Science News-Letter, March 22, 1930

HANDBOOK OF CHEMICAL MICROSCOPY—Emile Monnin Chamot and Clyde Walter Mason—*Wiley* ($4.50). Prof. Chamot, of Cornell, has probably done more than any other scientist to make the microscope an important instrument of the chemical laboratory. In this first volume of his new work he deals with the principles and use of the microscope and its accessories, and physical methods for the study of chemical problems. Volume II, in preparation, it is announced, will deal with chemical methods and inorganic chemical analysis.

Chemistry
Science News-Letter, March 22, 1930

WAVE MECHANICS—H. T. Flint—*Dutton* ($1.25). A brief and authoritative discussion of the most recent developments of physics—the new method of approach to atomic problems called wave mechanics and based on conceptions of continuity.

Physics
Science News-Letter, March 22, 1930

PRINCIPLES OF RADIO—Keith Henney—*Wiley* ($3.50). An exhaustive and thoroughly modern summary of the fundamentals upon which radio is based, containing valuable information for anyone who wants to know more of what makes the radio go.

Radio
Science News-Letter, March 22, 1930

THE TERMINOLOGY OF PHYSICAL SCIENCE—Duane Roller—*Univ. of Okla.* ($1). A useful compilation of common physical terms and their meaning, as well as a list of scientific words commonly mispronounced.

Physics
Science News-Letter, March 22, 1930

PSYCHOLOGY NORMAL AND ABNORMAL—J. W. Bridges—*Appleton* ($3.50). Medical students and full-fledged physicians are the audience to which this text book is addressed. It is unusual, in that it brings under one book cover both the normal psychological functions of the human being and also rather briefly the abnormalities arising from mental and nervous disorders. Both introspective and behaviorist viewpoints are considered.

Psychology
Science News-Letter, March 22, 1930

GEOLOGY: PHYSICAL AND HISTORICAL—H. F. Cleland—*American Book Co.* ($3.60). A new edition of a textbook that has passed through two successful issues. The author is especially happy in his illustrative diagrams, and many of his photographs which are as clear as diagrams

Geology
Science News-Letter, March 22, 1930

TO BEGIN WITH—Raymond Pearl—*Knopf* ($2). A new and revised edition of Prof. Pearl's stimulating "prophylaxis against pedantry."

General Science
Science News-Letter, March 22, 1930

THE LOWER TRIASSIC CEPHALOPOD FAUNA OF THE FORT DOUGLAS AREA, UTAH—Asa A. L. Mathews—*University of Chicago Press* ($2). A monographic account of the coiled kin of the nautilus that once swam in the seas that are now the Great American Desert.

Paleontology
Science News-Letter, March 22, 1930

THE STARS—George Forbes—*Cape and Smith* (60c). A little book (118 pages) with a surprisingly large amount of stellar information, including Orion, the spectra, stellar motions and variable stars. An excellent introduction to astronomy, and the bibliography will show where to go if this sample is appreciated.

Astronomy
Science News-Letter, March 22, 1930

THE THIRTEEN-MONTH CALENDAR—Julia E. Johœnsen—*Wilson* (90c). A complete compilation of material for and against the method of calendar reform by the addition of a new month. Intended chiefly for debate material, the book will be of interest to anyone who wants first-hand information on this proposed reform.

Chronology
Science News-Letter, March 22, 1930

THE ART OF SOUND PICTURES—Walter B. Pitkin and William M. Marston—*Appleton* ($2.50). Dr. Pitkin, a well-known writer, and Dr. Marston, a prominent psychologist, now both connected with the Equitable Pictures Corporation, have here collaborated to produce the first book telling how to write for the talkies. If you have ambitions to hear your literary labors bellowed forth from thousands of loud speakers in the talkie theaters, and to share some of the profits, this book tells you how to go about it.

Motion Pictures
Science News-Letter, March 22, 1930

CHASING ECLIPSES—Rebecca R. Joslin—*Walton* ($3). After two unsuccessful attempts (in 1905 on account of a cloud and in 1914 on account of a war), the author finally succeeded, along with 20,000,000 or so other people, in seeing an eclipse of the sun in 1925. In this little book she tells in an entertaining manner of her wanderings, and while it contains little astronomy it is well worth reading for the travel experiences.

Travel
Science News-Letter, March 22, 1930

A B C OF TELEVISION—Raymond Francis Yates—*Henley* ($3). A comprehensive treatise on this important new art that will enter our homes before many more years have passed. The author gives a history of television, giving full credit to an often forgotten pioneer, Paul Nipkow, and after developing the theory, modern methods, and possibilities of the future, he gives full details for simple experiments that the radio fan can perform.

Television
Science News-Letter, March 22, 1930

DIET AND EFFICIENCY—Harold H. G. Holck—*University of Chicago Press* ($1). A report of a 5-year experiment attempting to get objective evidence of any effects of "fletcherizing" or thorough to excessive mastication of food.

Nutrition
Science News-Letter, March 22, 1930

PHYSIOLOGICAL CHEMISTRY—R. C. Erb—*Chemical Publishing Co.* ($4.50). An extremely short textbook on physiological chemistry. Overloaded with structural formulae, written by the professor of chemistry at the Philadelphia College of Osteopathy.

Chemistry
Science News-Letter, March 22, 1930

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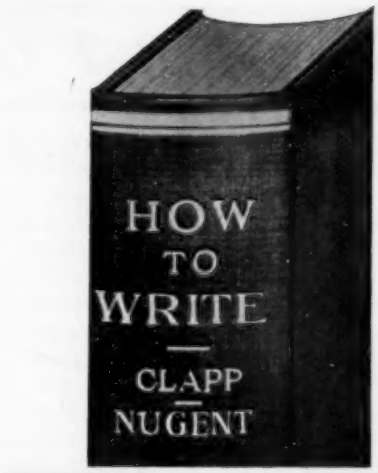

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